UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

EROSION STUDIES ON THE EARTH MATERIAL FROM THE SITE OF THE PROPOSED UNLINED EMERGENCY SPILLWAY AT FOSS DAM WASHITA PROJECT, OKLAHOMA

Hydraulic Laboratory Report No. Hyd-426

DIVISION OF ENGINEERING LABORATORIES

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Commissioner's Office--Denver
Division of Engineering Laboratories
Hydraulic Laboratory Branch
Hydraulic Structures and Equipment Section
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Laboratory Report No. Hyd-426
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Subject: Erosion studies on the earth material from the site of the proposed unlined emergency spillway at Foss Dam--Washita Project, Oklahoma

PURPOSE

The purpose of the study was to determine the general erosion characteristics of the firm, lean, layered clay through which the proposed unlined emergency spillway would pass.

CONCLUSIONS

1. The exposed material will air slake readily and the slaked material will be immediately swept away by flowing water.

2. Extensive erosion will occur when water is flowing due to the earth material expanding due to wetting and breaking up into flakes, chips, and slabs.

3. The natural overlapping of the loose chips and slabs tends to resist the wholesale removal of these pieces, but appreciable erosion occurs with velocities as low as 4 feet per second.

INTRODUCTION

The material tested was a very firm, lean clay, orange-red in color, and somewhat layered. An undisturbed sample approximately 1 foot square by 1 foot deep was obtained from the site at about elevation 1671. This sample was tested in an existing piece of laboratory equipment designed for erosion tests on sandstone materials. The equipment was not ideal for the earth sample tests but was used because it gave adequate results and was readily available. The test block was oriented so that

the stream of water from the 0.52- by 1.88-inch rectangular nozzle flowed over the top surface (Figure 1A). The layers within the material were generally parallel to the top surface and no special care was required as to which direction the flow passed across the block. The waterproof covering that had been placed on the sample to preserve the natural moisture content remained on the sample until just before the erosion tests were started. The test surface at the start of the tests is shown in Figure 1A.

RESULTS

Water was first passed over the sample at a velocity of 4 feet per second and a few loose flakes and chips were swept away. No further erosion was detected during the next several minutes. The velocity was then increased to 8 feet per second, which was the approximate flow velocity for expected spillway discharges, with the result that more small flakes were carried away. Soon larger chips and slabs with thicknesses to 1/4 inch began to break loose. When these pieces were carried away other thicker slabs loosened. After 1 hour of testing at 8 feet per second an estimated 1 inch of material had been removed from the block (Figure 1B). When accurate measurement of the depth of erosion was attempted it was found that the block had expanded greatly due to layers, which now appeared micalike in arrangement, separating and filling with the water. When a downward force was applied to the top of the block water oozed from the material and the material compressed. Upon release of the load the material expanded to about its previous bulk.

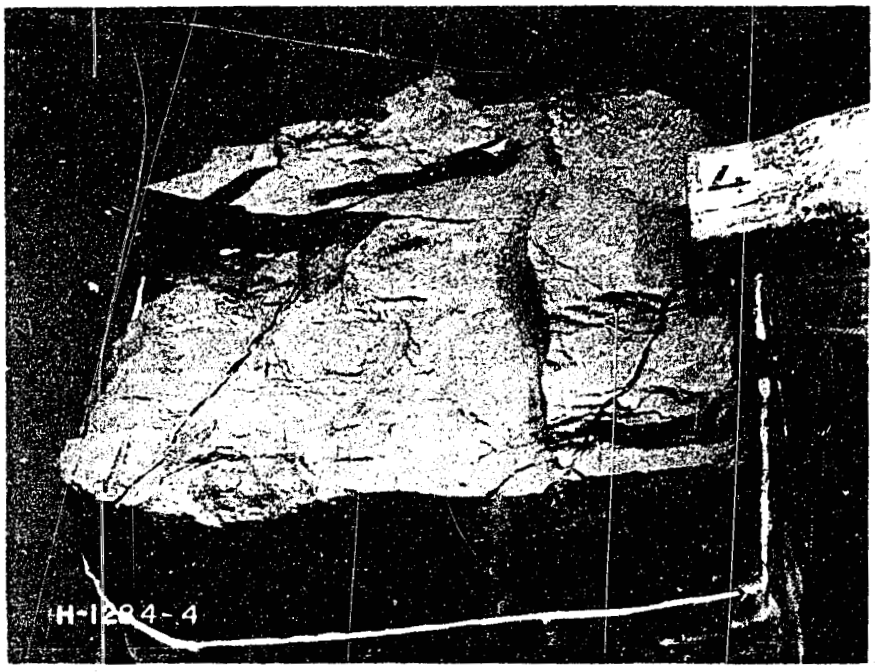
A repeat test was made on the block with a flow velocity of 4 feet per second after the surface had been trimmed down to obtain a relatively flat surface. The material within the block, which was now thoroughly saturated, was no longer in what had appeared to be massive form but consisted of horizontal, overlapping flakes, chips, and slabs. These pieces were easily carried away by the 4-foot per second flow velocity and only their shinglelike overlapping prevented wholesale removal of the pieces. New cracks and joints continued to appear in the pieces and at random time intervals material was carried away. A slight amount of material was also removed by dissolution, but this action was minor.

In a discussion with members of the Earth Laboratory, it was determined that this material will air slake to a depth of several inches and that this slaked material will be immediately removed by flowing water. Then erosion can be expected to occur as it did in the laboratory tests for as long as water flows over the spillway. However,

the rate of erosion in the field will be less than in the test block because water will not find its way into the material as readily as it did along the exposed faces of the test block and because there will be more interlocking of pieces in the field. In general it appears that this earth material will erode only slightly due to dissolution, but quite readily due to slaking and to breaking up into flakes, chips, and slabs.

Figure 1

Sample at start of test



Sample after 1 hour test with flow velocity of 8 feet per second

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